

THE ENTOMOLOGY OF ARISTOTLE

BY HARRY B. WEISS

NEW BRUNSWICK, N. J.

Few entomologists think of Aristotle in connection with their science, yet in addition to his extended activity in the fields of logic, rhetoric, politics, ethics, grammar, poetry, physiology, psychology, and natural history, Aristotle found time to devote some attention to insects as such. Zoology did not assume any definite shape until Aristotle had collected the observations of his precursors, added to them his own numerous findings, and attempted a natural system of classification.

Born in 384 B. C. at Stagira, a Greek colony, about seventy miles eastward from the capitol of Macedonia, Aristotle was brought up in a scientific atmosphere, his father, Nicomachus, having been physician-in-ordinary to the King of Macedonia, Amyntas II, father of Philip and grandfather of Alexander the Great. After the death of Aristotle's parents, when he was quite young, it is stated in some accounts that he was placed under the care of Proxenus, a citizen of Atarneus in Mysia. Here he is supposed to have squandered nearly all of his large inheritance and to have wasted his time in dissolute living, but it is difficult to imagine a comparatively young boy being so very rakish. When he was seventeen he traveled to Athens and commenced the study of philosophy under Plato. Here he lived for some twenty years, at a time when Athens was the center of learning for the entire Greek world. The wealthy citizens lived upon the income from their land, and the manufacturers, when they could afford it, bought land and joined the aristocracy. Skilled workers and small storekeepers crowded the city, and all manual workers were despised and were without social status. The narrow, unpaved streets wound between the unadorned mud-brick walls of low and for the most part windowless houses and were made the repositories of useless refuse from the households. Although the houses of even the wealthy Athenians were bare without, devoid of sanitation, and lacking in what are now

regarded as essential comforts, the interiors were made decorative with exquisite furniture, painted vases and handwrought metal utensils. The lower classes believed in magic and were entertained by wrestling, running, and boxing matches, chariot racing, heavy drinking and games of chance, and the city lived out-of-doors.

Upon the death of Plato in 347 B. C., Aristotle went to Atarneus in Mysia and lived with Hermias, who ruled Atarneus, marrying Pythias, the niece of Hermias, when he was thirty-seven years old. After the Persians had captured and killed Hermias in 344 B. C., Aristotle found life in Atarneus precarious, so he escaped to Mitylene, and two years later he was called to the court of Philip of Macedon to instruct Philip's son Alexander.

Philip, able and skillful in both politics and war, was extending his kingdom northward and eastward, and his activities north of the Ægean, where his conquests conflicted with the interests of the Greek states, were viewed in Athens with both trust and distrust. One party of which Isocrates was the leader was in favor of Philip and looked to him to unite and save the Greek world, while the anti-Macedonian party was led by Demosthenes, who denounced Philip as a barbarian whose object was to reduce the free Greek cities to slavery. After a series of battles, Philip defeated the Greek forces in 338 B. C. and became the head of a league of all the Greek states except Sparta.

During Aristotle's residence in Macedonia, which lasted seven years, he taught Alexander rhetoric, ethics, politics and physics, and continued his research in philosophy. At the court he was greatly respected and liberally supplied with money. Upon the death of Philip, who was treacherously assassinated in 336 B. C., during the wedding festivities of his daughter, Alexander became the King of Macedonia, and soon afterward commenced his Asiatic campaign. Previous to this time Aristotle returned to Athens, where he was well received and given permission to occupy the Lyceum, a large inclosure in the suburbs, where he established his renowned school later called the Peripatetic. In the morning he delivered lectures to select pupils, and in the evening discoursed popularly to the general public. Scholars

were attracted from all parts of Greece, and for some thirteen years the Lyceum flourished. Alexander kept in touch with him and placed at his disposal several thousand men who collected all kinds of animals for him, this material being the basis for his "History of Animals." According to Athenaeus, Aristotle received 800 talents from Alexander so that he could finish his "History of Animals," but doubt is thrown on this by a passage from Aelian.

Following Alexander's death in 323 B. C., brought on most likely by a drunken saturnalia, Aristotle found the atmosphere of Athens unhealthy, because of his friendliness to the Macedonian authority. His enemies among the followers of Plato and Isocrates could not make a political charge against him, as he was not active politically, and so they charged him with impiety because he had written a poem in praise of Hermias and had erected a statue of Hermias at Delphi. Aristotle, fearing that he could not successfully meet the attacks of the anti-Macedonian party, took advantage of an Athenian law which permitted an accused person to avoid a trial by going into exile voluntarily, and escaped to Chalcis in Euboea, where he died naturally soon afterward in 322 B. C., at the age of about sixty-two.

Of his personal appearance, Macgillivray records that he was not highly favored, and Lones describes him, according to ancient writers, as "rather short and slim," with small eyes and lisping speech. Although not robust physically, he was full of energy and action and paid much attention to his personal appearance. According to Antipater, his conduct was polite and persuasive. In his will his family received careful consideration, as did his slaves.

His industry was enormous, and most of his writings were produced from 335 B. C. to 323 B. C., during his stay at the Lyceum. The separation of his work from that of his students and followers has been attended with much difficulty. As a whole his writings are pertinent and the subjects are arranged orderly. The abstract generalization present in some of his books is usually absent in his "History of Animals" and works on zoology wherein "facts" are recorded. Lones states that Aristotle "is

eminently practical and is the first to condescend to regard the observations of things themselves as an important part of the foundation of knowledge." As the founder of natural history he attempted to cover an enormous field, and, as would be expected, his mistakes are numerous, due in part to his reliance upon the observations of others. Yet his advances were greater than those of any of his predecessors, and all during the Middle Ages Aristotle's science was thought to be the last word.

Some of his views about insects are set forth below, practically all of them having been extracted from Lones's volume on "Aristotle's Researches in Natural Science."¹ There is, of course, always some risk attached to the practice of presenting parts of an author's work as complete entities, without regard for the value of such parts in his whole scheme. However, it is believed that in the case of Aristotle's "insects" this can be done without injustice to the author.

Concerning spontaneous generation, Aristotle thought that the vital principle was more important than the accompanying matter, but his views as to how the two came together are not clear. Quoting Lones, Aristotle apparently believed that "the inanimate matter" underwent "some kind of maturing process in the presence of moisture and at a suitable high temperature, the moisture containing some breath of life, and everything being in some way full of vital principle. Then frothy bubbles of this specially prepared matter" were "formed, and within these generation" proceeded "rapidly." The kinds of life so formed depended partly upon the nature of the matter within the bubbles and partly upon "the nature of the vital principle enclosed." An additional statement on this subject by Aristotle is as follows: "The part of the rudimentary vital principle caught up and enclosed in the breath of life makes the germ or embryo and imparts movement." He thought that spontaneous generation took place in some of the flowerless plants, in many of what are now called gastropods and lamellibranchs, and in some insects and fishes. Although these animals are structurally different they resembled each other, according to Aristotle, in being "engendered" from inanimate matter. Lones calls attention to the

¹ London, 1912.

fact that "some of these forms of life resemble one another sufficiently to form an assemblage which unites inanimate matter with higher plants and animals, such as flowering plants, insects, crustaceans, cephalopods and the numerous animals constituting Aristotle's *Enaima*, which corresponds to a large extent with the *Vertebrata*." Although Aristotle apparently did not believe in generation from the earth itself, he assented to the liability of the production of men and some quadrupeds from such lower forms of life as worms, larvæ or eggs.

As to respiration, he thought that animals without lungs could not respire and that in the case of animals with lungs respiration served only to cool the blood and heart, these being the chief centres of heat. In view of this, his *Entoma* or insects could not respire, and from supporting evidence he says that insects live when cut into several parts, and that flies and bees swim in water for a long time unless it is very hot or very cold.

Aristotle's description of the insect alimentary canal is very general. Most of his *Entoma*, according to his writings, have a divisionless canal which passes directly from the mouth to the anus, but in a few it is coiled and in others, like the locust, there is a stomach followed by a straight or coiled intestine.

He believed, correctly, that insects have a sense of smell, and calls attention to the keenness of this sense in bees.

Aristotle paid considerable attention to the transformations of some of his *Entoma*, and this is set forth as follows by Lones. "All his *ENTOMA* produce *skolekes*, or all, except certain *Lepidoptera* which produce seed-like bodies containing fluid. The passages relating to his *skolekes*, are too numerous to be given in full, but an epitome of the most important follows, so far as the difficult nature of the subject permits.

"He appears to have been aware of the existence of the ova or eggs of some of his *ENTOMA*, specially certain butterflies and moths, locusts and spiders, but considered them to be not eggs but egg-like *skolekes*. The ova of many *ENTOMA* escaped his notice, but he was aware of the existence of their *skolekes*, and believed that these were the first products of generation. The *skolekes* fed, grew rapidly, and underwent changes, more or less complex, until they passed into the pupa or *chrysalis* form.

“The skolekes of the various kinds of ENTOMA are not treated by Aristotle in the same way. When dealing with those of bees, wasps, and the like, the larvæ are called skolekes right up to the pupa stage; on the other hand, the skolekes of butterflies and moths are said to become kampai, or caterpillars, before they become pupæ. The apparently great difference between the caterpillars of butterflies and moths, and the maggots of bees, wasps, and flies, was probably the cause of this difference of treatment, but he considered both caterpillars and maggots to be skolekes finally into the “real eggs,” or pupæ.

“His views on this subject are set forth in fairly clear language. He states that ENTOMA brings forth skolekes at first, but these become egg-like in the course of their development, for the so-called chrysalis is functionally equivalent to an egg. He also says: ‘For we must consider caterpillars to be a kind of skolex, and also the (generative products) of spiders, and yet it may seem that some of these and many others resemble eggs, because of their roundness, but they should not be defined by their form, nor their hardness and softness, but by their producing an animal as the result of a change of the whole and not a part. When they have completely attained the skolex form, and have become of full size, they are, as it were, eggs, for the skin hardens about them, and they become motionless at this time. This is evident in the skolekes of bees and wasps and in caterpillars. The reason for it is that, because of the imperfect nature of the animals, their ‘eggs’ are produced, as it were, before their time, the skolex being, as it were, an egg which is still soft and in process of growth.’

“This is the most important passage on the skolex in all Aristotle’s works. It shows clearly, in conjunction with the other passages cited, that his skolex is an immature product of generation, which grows and finally becomes a pupa, or, so Aristotle believed, an ‘egg,’ giving birth to the perfect animal. It differed from the eggs of a bird, which has a hard shell and does not grow, the young bird being formed from a part of the egg, the remainder serving as food.

“His discussion of the generation of bees is particularly interesting. He refers to the many different opinions which had been

given on the subject, and says that much uncertainty existed about the mode of generation of bees. He seems to think that a kind of hermaphroditism occurs among the workers, and finally decides that the rulers or king (queens) generate both themselves and the workers, that these generate the drones, and that these generate nothing, but are idle, while the queens remain in the hives free from all unnecessary labour.

“It is now known that the queen of a hive generates queens, workers, and drones, the workers being normally barren females, and the drones males; parthenogenesis sometimes occurs. The production of a queen from a fertilized egg depends on the supply of a superior quality of food, called ‘royal jelly,’ to the hatched-out larva, and this feeding is arranged by those bees which act as nurses. It is sufficient for the queen to be impregnated once only by a drone, for the purpose of depositing vast numbers of fertilized eggs.”

Aristotle defined his *Entoma* as follows: “I call those animals *Entoma* which have incisions in their bodies, either in their ventral parts, or in these and also their dorsal parts.” Although this definition is broad enough to include most of the *Arthropoda*, *Vermes* and *Echinodermata*, Aristotle, according to various qualifying parts in his works, restricted his *Entoma* to much narrower limits, excluding from it animals not possessing many legs and stating that there is a certain ratio between the number of legs and the length of the body or number of indentations, and that a reduction in the number of legs is made up for by the presence of wings. As a matter of fact, his *Entoma* are mainly “butterflies, moths, beetles, bees, wasps, hornets, ants, houseflies, gadflies, gnats, dayflies, grasshoppers, locusts, spiders, scorpions, centipedes and millipedes.” He separated the crustaceans from his *Entoma*, which many naturalists who came after him did not. Agassiz said that Aristotle divided the group more correctly than Linnæus.

Aristotle mentions about sixty *Entoma*, but few of these can be identified. He knew that the locust oviposits in the ground, that the young resemble the parent, and that a complete metamorphosis is lacking. He thought, in common with ancient authors, that the cicada fed on dew only, and that the singing

was due to the "friction of the air on the membrane beneath the hypozoma or part close to the division between the thorax and abdomen." The fact that the males only sing is mentioned by him, but this was well known to the ancients. He states that the cicada lays its eggs in certain plants and in the ground, and speaks of the larva undergoing a kind of transformation. He knew of the mayfly and says that Ephemeron has four legs, four wings, and lives but a day. For several species of Lepidoptera, he uses the word Psyche, and refers to the cabbage butterfly being produced from "something smaller than millet seeds" on the leaves of cabbage. Concerning some of the Geometridæ he says they are produced "from caterpillars which form waves as they walk." He knew that larvæ in woollens resulted in certain species of Tinea, which he called Setes. His Kouleoptera have elytra and are without "stings," but few can be identified although some of his names such as Kleros, Karabos and Melolonthæ are, in a modified form, in use at present. His Kantharos is *Scarabeus sacer*, the sacred beetle of the ancient Egyptians, and his larvæ of Kleros are thought to be those of *Trichodes apiarius*, a species which infests beehives. His Karabos has been identified as the rock lobster *Palinurus vulgaris*. Many remarks about bees and wasps are made by Aristotle, and in connection with bees he observes that during each flight they visit only flowers of the same kind.

In the classification of his animals constructed from his writings, two main groups are apparent, the Enaima (Vertebrata) and the Anaima (Invertebrata), and his Entoma form a subdivision of his Anaima or animals without blood. Some authors have reconstructed in some detail the classification of his Entoma, but it is doubtful if Aristotle really had such an orderly arrangement in mind.

Aristotle's most important works on natural history are the "History of Animals," "Parts of Animals" and "Generation of Animals." The influence of his writings as a whole reached its peak during the early part of the 14th Century. Shortly after Dante's time his work began to be reviewed unsympathetically, and after the Revival of Learning the criticism became pronounced, his philosophy and the Church as well being attacked.

Lones states that in 1536, Ramus selected the sweeping title "Everything that Aristotle taught is false" for his thesis leading to a degree at Paris, and defended his arguments so expertly that he obtained it. Patrizi, Bacon, Galileo and other experimentalists all attacked Aristotle's doctrines, and by the first half of the 18th Century he was very much neglected. During the period when the interest in his work was lessening, his zoological work was being given increasing attention. Gesner's "Historia Animalium," is full of Aristotelianisms, and Willughby, Ray and Artedi were all students of Aristotle. A renewal of interest in Aristotle's work commenced in the late 18th and early 19th centuries, and has continued.

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